THE OCCURRENCE AND ORIGIN OF THE GRANITE - - META-ARKOSE ERRATICS IN THE ORDOVICIAN BLAKELY SANDSTONE, ARKANSAS

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META-ARKOSE ERRATICS IN THE ORDOVICIAN BLAKELY SANDSTONE, ARKANSAS

By Charles G. Stone[1] and Boyd R. Haley[2]

INTRODUCTION

The Blakely Sandstone of probable late Early Ordovician age was formally named by H. D. Miser (1917, p. 67) from outcrops on Blakely Mountain in Garland County, Arkansas (sec. 32, T. 1 S., R. 20 W.,) as a result of the definitive work by A. H. Purdue and H. D. Miser (1923) on the Hot Springs District. They reported that the formation is about 500 feet thick and is composed of interbedded sandstone and shale. They also described several thick beds of conglomeratic sandstone in the Blakely, along the northern border of the Hot Springs quadrangle in eastern Garland County. Sandstone, limestone and chert clasts were found in the sandstone but no granitic fragments were recognized. Miser and Purdue (1929, p. 29) mapped the Blakely from the Hot Springs quadrangle west to the vicinity of Norman (Womble), in Montgomery County, Arkansas, but did not describe more conglomeratic sandstone. Recent mapping for the state geologic map has shown that the Blakely crops out from Norman west to near the western boundary of Montgomery County (Fig. 1).

DESCRIPTION OF BOULDER DEPOSITS

In 1943, H. D. Miser (written and verbal commun., 1962) and A. E. J. Engel found a small cobble of "anorthosite" in the Blakely Sandstone, in a newly excavated trench at the quartz mine on Miller Mountain (S½, sec. 2, T. 1 S., R. 21 W.,) in northwestern Garland County (Fig. 1). Engel (1952, p. 189-192) describes many conglomerates and breccias in the Blakely of northern Garland County but does not refer to granitic rock or to the "anorthosite" cobble.

D. F. Holbrook (1955) investigated the Uebergang uranium prospect and adjoining properties along a small east-west trending ridge in secs. 3 and 4, T. 1 N., R. 15 W., in northern Saline County (Fig. 1). In this area, rounded boulders, as much as 2 feet in diameter, of vuggy, coarse-grained, quartz-feldspar rock are scattered on the surface. Samples of the radioactive rock were chemically analyzed by the U. S. Geological Survey and the radioactivity was ascribed primarily to an unidentified thorium mineral (maximum of 1.5 percent Th^{232} and 0.019 percent U^3O^8).

Prospect trenches on the Uebergang property in the SE¼ of sec. 3, were examined by P. J. Sterling, C. G. Stone, and D. F. Holbrook in 1959-60 while mapping the Benton quadrangle. They found quartz-feldspar and feldspathic quartzite boulders, as much as 5 feet in diameter in the uppermost part of the Blakely Sandstone; in a zone of red clay residuum that was interbedded with altered "talcose" shale, siltstone and dense glossy gray-black chert. The quartz-feldspar rock was tentatively classified as igneous. Later work disclosed that the granite and feldspathic quartzite boulders occur in several beds in the Blakely Sandstone, along a narrow outcrop belt which trends from about 1/2 mile south of Paron eastward a short distance into Pulaski County. In the SW¼, SE¼, sec. 4, T. 1 N., R. 16 W., southeast of Paron (Fig. 1), in the middle of the Blakely Sandstone, an isolated mass of quartzitic sandstone about 75 feet long contains many feldspar-rich layers. At roadcuts along Arkansas Highway 9 north of Crows (sec. 1, T. 1 S., R. 17 W.,) in central Saline County (Fig. 1), small partially decomposed granitic boulders, small gray-black chert masses, and some red clay residuum were observed, in 1960-61, in beds of decalcified brown siltstone and maroon shale at the top of the Blakely. Small, decomposed granite pebbles were found in the upper and middle parts of the Blakely at several localities between the Crows area and an area near Mountain Valley, in eastern Garland County. Samples from these sites were only slightly radioactive.

In 1960, a sample of the coarse-grained granitic rock from the Uebergang prospect was submitted to K. C. Jackson, University of Arkansas, for petrographic study. Jackson (written commun., 1962) reported that the rock contained microcline, microcline microperthite and minor quantities of oligoclase feldspar, fibrous amphibole and replaced mica. He concluded that the rock was a meta-arkose and that the original detritus was derived from a simple granitic terrane (see Jackson, this Volume). Stone and Sterling (1962, p. 388) briefly summarized the descriptions of the meta-arkose boulders in the Blakely Sandstone of the eastern Ouachita Mountains, Arkansas. Sterling and others (1966, p. 181) observed that the meta-arkose boulders in the Blakely were larger in northern Saline County, and suggested that they were derived from outcrops of Precambrian rocks during Blakely time. The Precambrian rocks probably formed submarine highs which were northeast of the main area of Blakely deposition.

In the fall of 1967, O. A. Wise, H. D. Miser and N. A. Sommers (Sommers, 1971, p. 23) investigated the boulder-bearing strata in the middle and upper part of the Blakely Sandstone at Point 50 on the eastern end of Lake Ouachita (NW¼, sec. 36, T. 1 S., R. 21 W.,) in Garland County (Fig. 1). At this locality, meta-arkose and granite cobbles and boulders, as much as 5 feet in diameter, are embedded in an intricately folded limy conglomeratic sandstone which is 20-30 feet thick. Other clasts in the sandstone consist of limy siltstone, silty limestone, gray-black chert,

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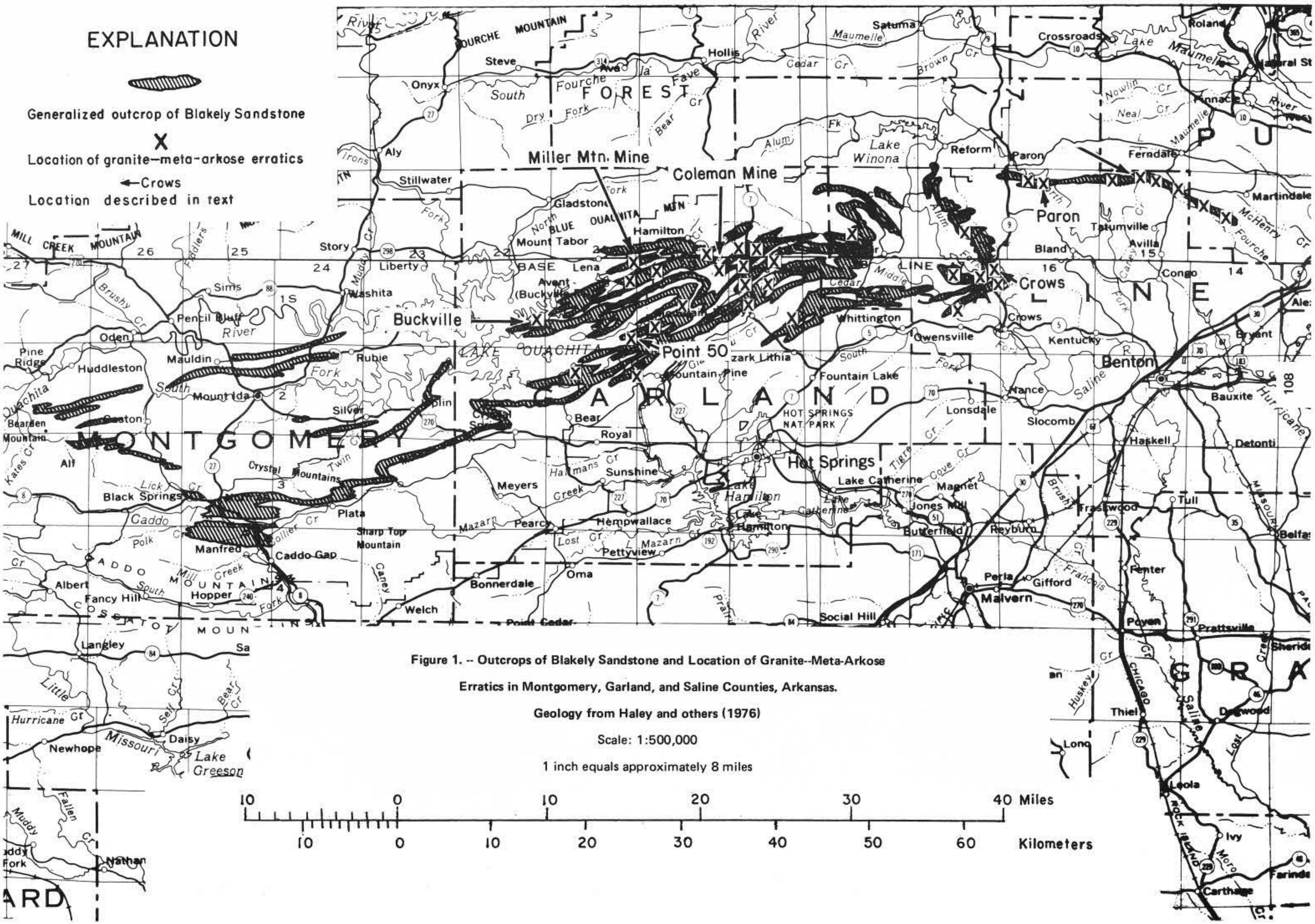

Figure 1. -- Outcrops of Blakely Sandstone and Location of Granite--Meta-Arkose Erratics in Montgomery, Garland, and Saline Counties, Arkansas.

Geology from Haley and others (1976)

Scale: 1:500,000

1 inch equals approximately 8 miles

Figure 2. -- Small, round to angular, light-colored, altered, granite, meta-arkose and arkosic siltstone erratics in the mélange part of decalcified Blakely Sandstone, with dissecting milky quartz veins; along north wall of Coleman quartz mine near Blue Springs, in northern Garland County.

dense dolomitic limestone, limy sandstone, sandstone, quartzite, and one small cobble of very light colored, dense, fine-grained limestone which resembles updip (platform) Lower Ordovician strata.

In the spring of 1968, B. R. Haley, C. G. Stone, M. B. Woodward, and others examined thick mélange zones mostly in the middle part of the Blakely Sandstone at the Coleman quartz mines (SW¼, NW¼, and the NW¼, SW¼, sec. 12, T. 1 S., R. 20 W.,) and at other quartz mines near the community of Blue Springs, in Garland County. The mélange contains many round to subangular pebbles, cobbles and boulders of kaolinized, meta-arkose, arkose and granite, in a soft, weathered, sandstone along the walls of open pits (Fig. 2). The boulders at the Coleman quartz mine attain a maximum diameter of 45 feet, and their long axes generally parallel the bedding of the sandstone. These granite erratics are very similar to those in northern Saline County, except that a few contain abundant muscovite, some contain a distinctive smoky-gray quartz, and most seem more decomposed. Several rounded kaolinized granite cobbles, enclosed in meta-arkose and arkose boulders, were found at the Coleman mine.

In the fall of 1968, several geologists of the Arkansas Geological Commission and H. D. Miser revisited the Miller Mountain quartz mines, in northwestern Garland County, where Engel and Miser had earlier found the "anorthosite" cobble. A thorough examination of the small pits resulted in the discovery of many pebbles, cobbles and small boulders of kaolinized granite, meta-arkose and sedimentary rocks, but no anorthosite, in poorly exposed beds of decalcified conglomeratic sandstone. Miser then offered the opinion that the "anorthosite" cobble found in the earlier visit was probably a fragment of feldspar-rich granite.

While the authors and others were mapping the Ouachita Mountains for the new Arkansas State Geologic Map, granite and meta-arkose pebbles, cobbles, and boulders were discovered in several parts of the Blakely Sandstone in the region between Ferndale and the Montgomery-Garland County line (Fig. 1). Only a few kaolinitic pebbles and cobbles which may be weathered meta-arkose or granite were found in the Blakely in Montgomery County. Brieva (1963, p. 50) and Williamson (1973, p. 30) describe minor quantities of detrital feldspar in the Blakely west of Garland County, but they apparently did not find erratics. Brieva (1963, p. 68) also states that the nontronite in shale of the Mazarn and Blakely was probably derived from the alteration of volcanic ash and glass.

Samples of granite from the Blakely Sandstone in northern Saline County were submitted to R. E. Denison of Mobil Research in 1970 for petrographic study and age determination. Denison (written commun., 1971) stated that these rocks are comparable to epizonal granites found in the south-central United States. He also reported that the age determinations were erratic, ranging from 283 to 489 + or – million years, and probably did not indicate true age (Denison and others, this Volume).

Studies by Williamson (1973), Williamson and Davies (1973) and Davies and Williamson (1973) (see Davies and Williamson, this Volume) describe two general types of sandstone in the Blakely. Williamson (1973, pp. 54 and 60) states that "the medium-grained sandstone was derived from a stable platform north of the Blakely outcrops and that the fine-grained sandstone and kaolinized granite and meta-arkose erratics were derived from a continental (sialic) source south of the outcrops. Perhaps Llanoria or Africa was the southern source of sediment."

CLASTS OF IGNEOUS AND METAMORPHIC ROCKS IN OTHER FORMATIONS IN THE OUACHITA MOUNTAINS

Small pebbles of granitic rock in limestone of the Early Ordovician Collier Shale were first reported by H. D. Miser and O. A. Wise (personal commun., 1961) in the SE¼, NW¼, sec. 35, T. 2 S., R. 26 W., in Montgomery County. We have found small fragments of granitic rock in limestone and conglomeratic limestone in the Collier Shale and the Early Ordovician Crystal Mountain Sandstone, at several localities in Montgomery County and western Garland County. Small cobbles of red phyllite were also found in a 10-15 foot thick bed of conglomeratic limestone in the upper Collier, on the south shore of Lake Ouachita near the Garland and Montgomery County line. Flores (1962, p. 21) and others have described the oolites and pellets associated with some of the limestones and the conglomeratic limestones.

The Collier and Crystal Mountain Formations do not crop out in the eastern Ouachita Mountains of Arkansas and, consequently, have been examined only in a small area. Near Broken Bow, Oklahoma, Honess (1923, pp. 45 and 49) described boulder and conglomeratic zones in the Collier, probable Collier, and Crystal Mountain Formations and stated that granitic gravel, arkosic fragments, and oolitic structures occur in the Collier limestone.

Some granitic erratics have also been tentatively identified in the black chert and shale breccias in the upper part of the Early Ordovician Mazarn Shale near Jessieville in northern Garland County.

Thin silty sandstone and conglomeratic (commonly phosphatic) sandstone or limestone in the Lower and Middle Ordovician Womble Shale of the Ouachita Mountains, are described by Honess (1923, p. 62), Miser and Purdue (1929, p. 32), Stone and Sterling (1962, p. 389-390), Lozano (1963, p. 9), Sterling and others (1966, p. 181), and Stone and others (1973, p. 52). Only scant igneous and metamorphic clasts have been reported in the Womble. The sill-like soapstone-serpentine masses in the Womble and Bigfork Formations of Middle and Upper Ordovician age in northern Saline County, Arkansas, are altered peridotite that was probably intruded in Middle Ordovician to Late Pennsylvanian time or slightly later (Sterling and others, 1966, p. 181).

Near Broken Bow, Oklahoma, Honess (1923, p. 210-212) describes a thin diorite sill intruded into the Womble sandstones. He further notes (p. 261) the highly fractured nature of this rock and indicates that it antedates the deformation in the area. The diorite sill thus was probably intruded in Middle Ordovician to Late Pennsylvanian time or slightly later.

J. Perrin Smith (Williams, 1891, p. 409) found decomposed igneous boulders (as much as 4 feet in diameter) in limestone and shale along small streams in secs. 23, 24, and 28, T. 1 S., R. 22 W., near Buckville (Avant), Arkansas, in western Garland County. He concluded that these boulders represented five separate syenite dikes. Most of the boulders are now beneath Lake Ouachita, but we are assuming that they are granitic erratics in a conglomerate of the Blakely Sandstone or possibly of the lowermost Womble Shale.

A few biotite-rich granite pebbles were discovered by the authors in thick beds of conglomerate in the Missouri Mountain Shale of Silurian age, the Arkansas Novaculite of Devonian and Mississippian age, and the Stanley Shale of Mississippian age, near Goosepond Mountain in western Saline County and at other localities in northern Garland County. Because of the spatial distribution of the conglomerates, we propose that the granite pebbles were derived from submarine scarps or ridges that were north of Garland County along the continental slope of a craton.

Honess (1923, pp. 108, 126, 135, and 136) reported granite, porphyritic basalt, and volcanic ash fragments in conglomerates of the Missouri Mountain Shale and Arkansas Novaculite, in the Broken Bow area of Oklahoma. He concluded that the volcanic ash was deposited contemporaneously with some beds in these formations.

Acidic volcanic tuffs in the Mississippian Stanley Shale are described by Miser and Purdue (1929, p. 62-64), and others. The Hatton tuff occurs near the base of the Stanley and is thickest in the southwestern part of the Ouachita Mountains. Regional changes in the thickness and grain-size of the tuff are evidence that the volcanic source was south of the Ouachita Mountains of Arkansas. Thin tuff beds containing andesine plagioclase feldspar are also indicated in the Chickasaw Creek Member of the upper Stanley in the frontal Ouachita Mountains by Seely (1963, pp. 67 and 132), and others. It has been tentatively proposed by some workers that this volcanic material was derived from the south or southeast, but this has not yet been confirmed by studies in the southern Ouachita Mountains.

CONCLUSIONS

The spatial distribution of the clastics and erratic boulders in the Blakely Sandstone are not easily determined because: (1) the complex structure includes refolded and recumbent strata, thrust faults with displacements of at least twelve miles, and windows and klippens; (2) the boulder-bearing beds are generally calcareous, weather rapidly, and are therefore poorly exposed; and (3) most of the granitic clasts weather to kaolinitic clay, particularly where they are above the ground-water table.

The authors herein postulate that during deposition of the Blakely, clay, silt, fine-to coarse-grained sand, and siliceous and calcareous muds were carried southward across the continental shelf. Some of the sediment was deposited on the shelf and some was transported across the shelf to accumulate on the continental slope. Sediment was also transported through submarine canyons to spread southward and westward from the canyons by turbidity

and bottom currents. Sediment was possibly also carried from the east or southeast by these currents. The granitic clasts were eroded from outcrops along the edge of the shelf, from the sides of submarine canyons, or from submarine ridges or highs near the site of deposition. The boulder-bearing strata of the Blakely have resulted from the mixing action that occurred during submarine slumps, slides, and in turbidity currents which moved down and along the continental slope.

The authors believe that these granitic rocks are both igneous and metamorphic in origin and are probably of Precambrian age, but possibly of Cambrian age, and that the source area of these rocks is now buried beneath the northward-thrusted Ouachita Mountains. In all probability the granite-meta-arkose fragments in the other Ordovician formations were emplaced by the same sedimentary processes and are from the same general source area. The possible volcanic detritus in the Blakely and other formations cannot be ignored but the eruptive centers, if present, were not in the area of deposition, because the soapstone-serpentine in Saline County, Arkansas, and the diorite sill near Broken Bow, Oklahoma, are the only known intrusives of probable Paleozoic age in the Ouachita Mountain region.

The igneous and volcanic rock fragments described by Honess (1923, pp. 108, 126, and 135) in the Missouri Mountain Shale and Arkansas Novaculite of Silurian-Devonian-lowest Mississippian age, in the Broken Bow area of Oklahoma, are evidence of either a new source area or of rejuvenated igneous activity in portions of the older Blakely source area. Since no similar fragments have been reported in these formations to the north or northwest in the Ouachita Mountains, in the Black Knob Ridge or Potato Hills of Oklahoma (Hendricks and others, 1937, p. 11-12), it seems that another younger source area existed to the south. The minor fragments of granite found in conglomerates in the north central Ouachita Mountains of Arkansas, are related to submarine detachments derived from a northern source, from either the older metamorphic-igneous complex or possibly from concurrent igneous activity. The areal distribution of the Hatton Tuff, in the lower Stanley Shale of Mississippian age, indicates that a volcanic area was southwest of the depositional site during the Mississippian Period.

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